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Handley et al.

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(54) **MATERIALS SUITABLE AS SUBSTITUTES FOR PEAT MOSSES AND PROCESSES AND APPARATUS THEREFOR**

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C05F 11/00 (2006.01)
C05G 5/12 (2020.01)
(Continued)

(52) **U.S. Cl.**
CPC ***C05F 11/00*** (2013.01); ***C05G 3/80*** (2020.02); ***C05G 5/12*** (2020.02); ***C09K 17/16*** (2013.01); ***C09K 17/50*** (2013.01); ***C09K 17/52*** (2013.01)

(58) **Field of Classification Search**
None
See application file for complete search history.

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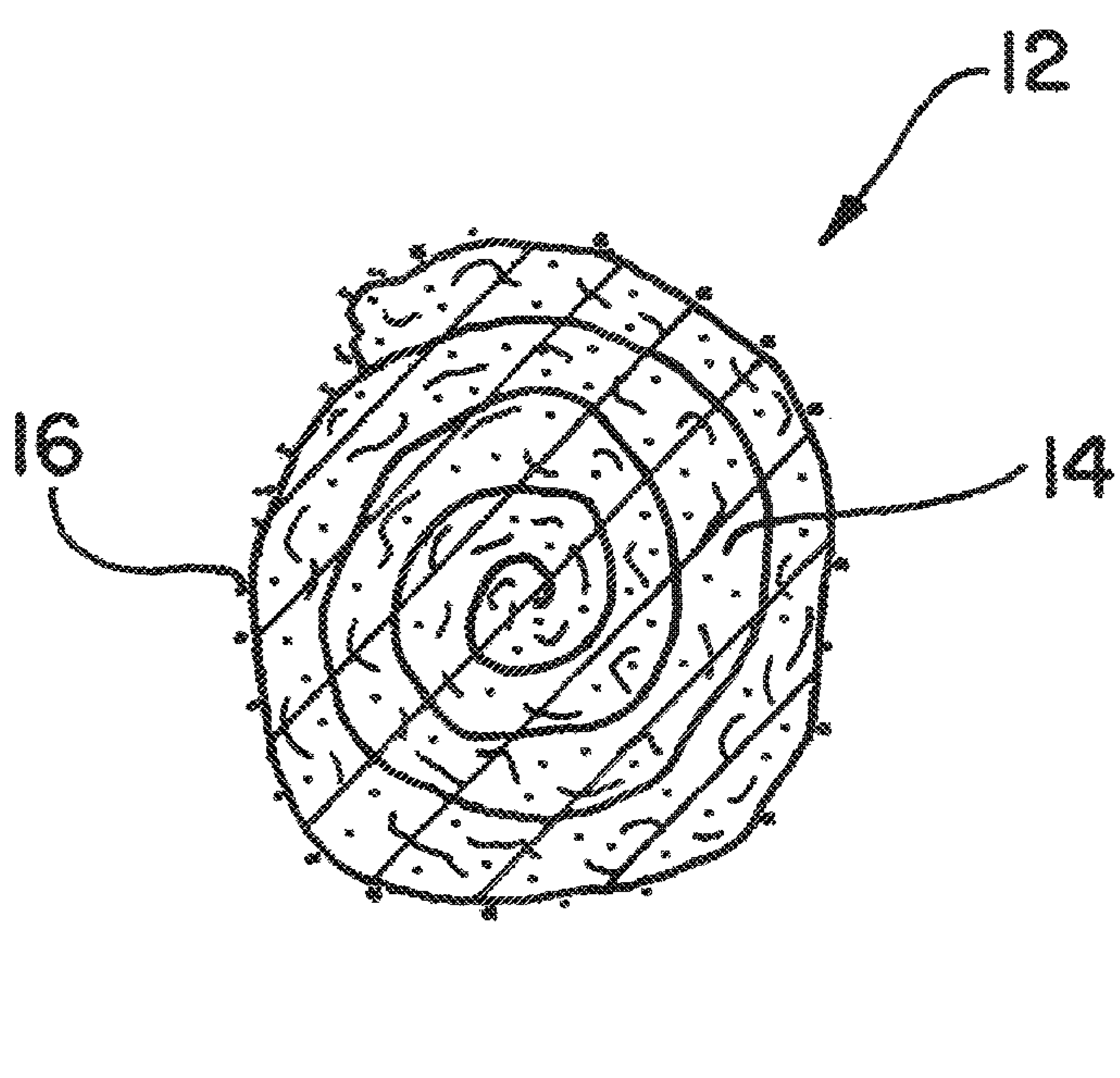
(57) **ABSTRACT**

Processes capable of producing bulk materials suitable for use by the horticulture industry, resulting bulk materials produced thereby, and applications for these processes and materials. Preferred bulk materials have physical properties similar to peat moss and comprise individual materials, each at least partially having a twisted, curled, clumped and rolled structure. The individual materials may further comprise small granular particles dispersed throughout the twisted, curled, clumped and rolled structure. The individual materials may be rolled fibers such that the bulk material has physical properties similar to *Sphagnum* peat moss so as to be particularly suitable as, for example, a soil conditioner, an absorbent material, a chemical carrier, or a filtering material. Alternatively, the individual materials may be rolled particles such that the bulk material has physical properties similar to milled peat moss so as to be particularly suitable as propagation media.

12 Claims, 9 Drawing Sheets



(51) **Int. Cl.**

C09K 17/50	(2006.01)
C09K 17/52	(2006.01)
C09K 17/16	(2006.01)
C05G 3/80	(2020.01)

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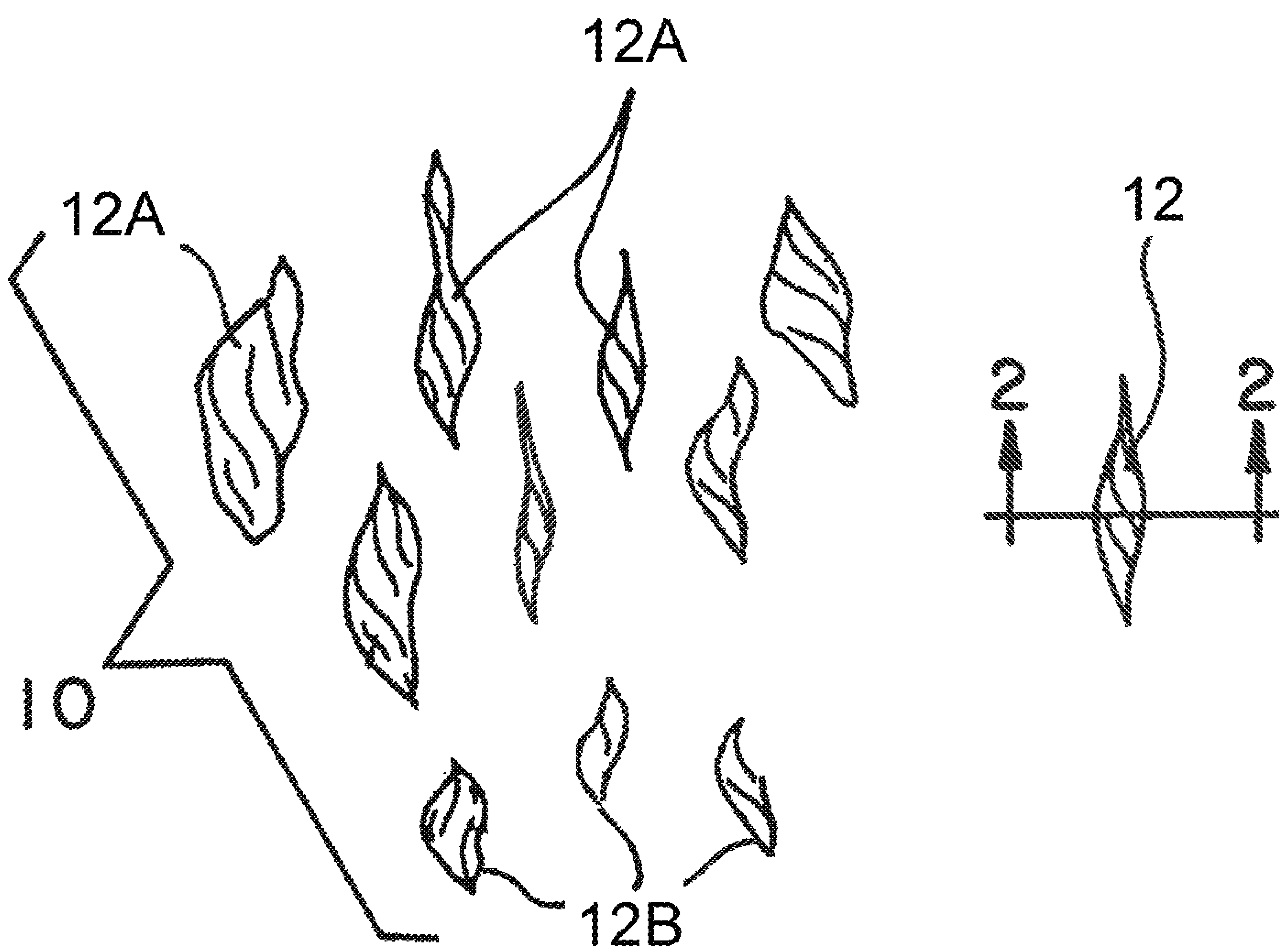

FIG. 1

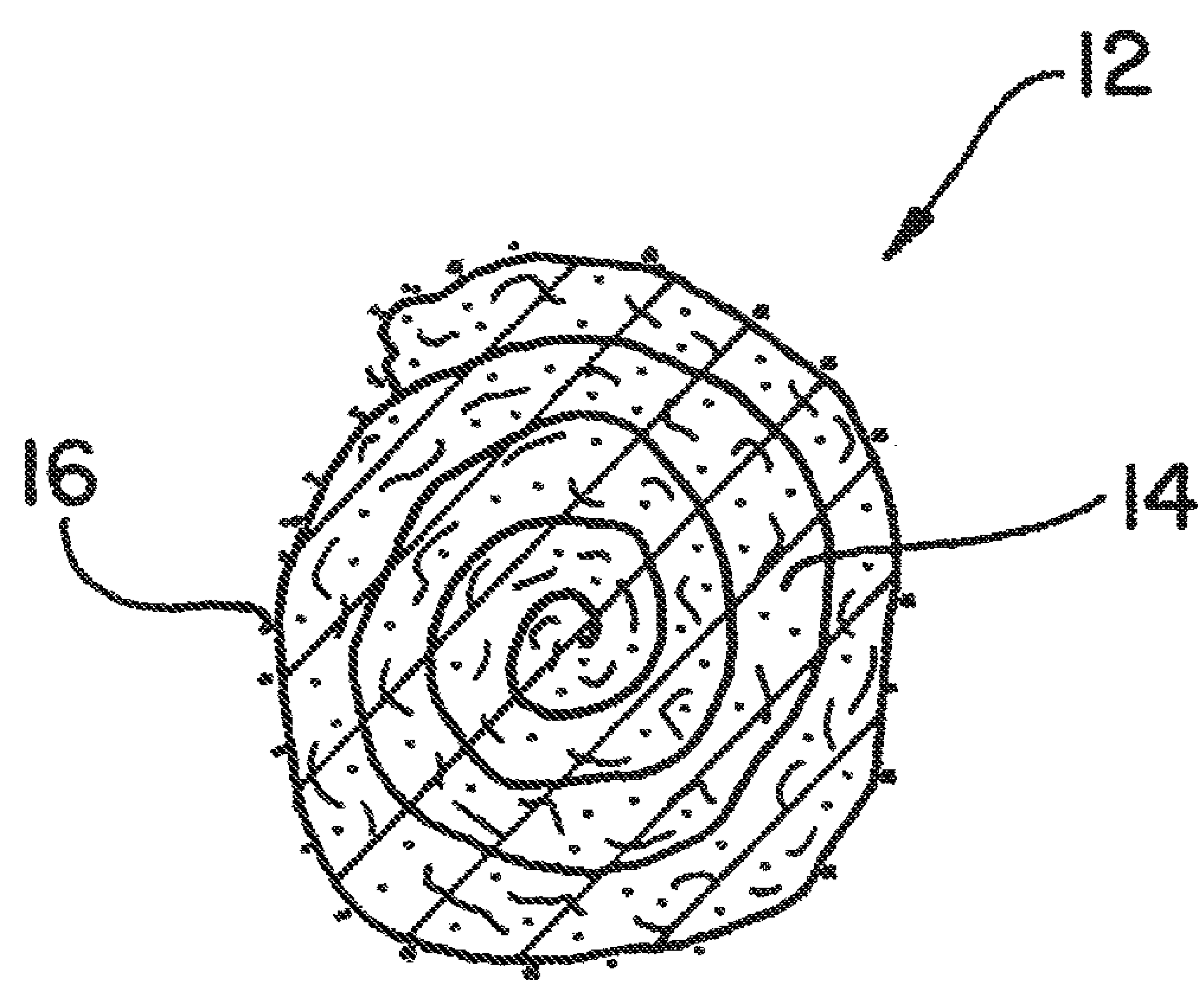

FIG. 2

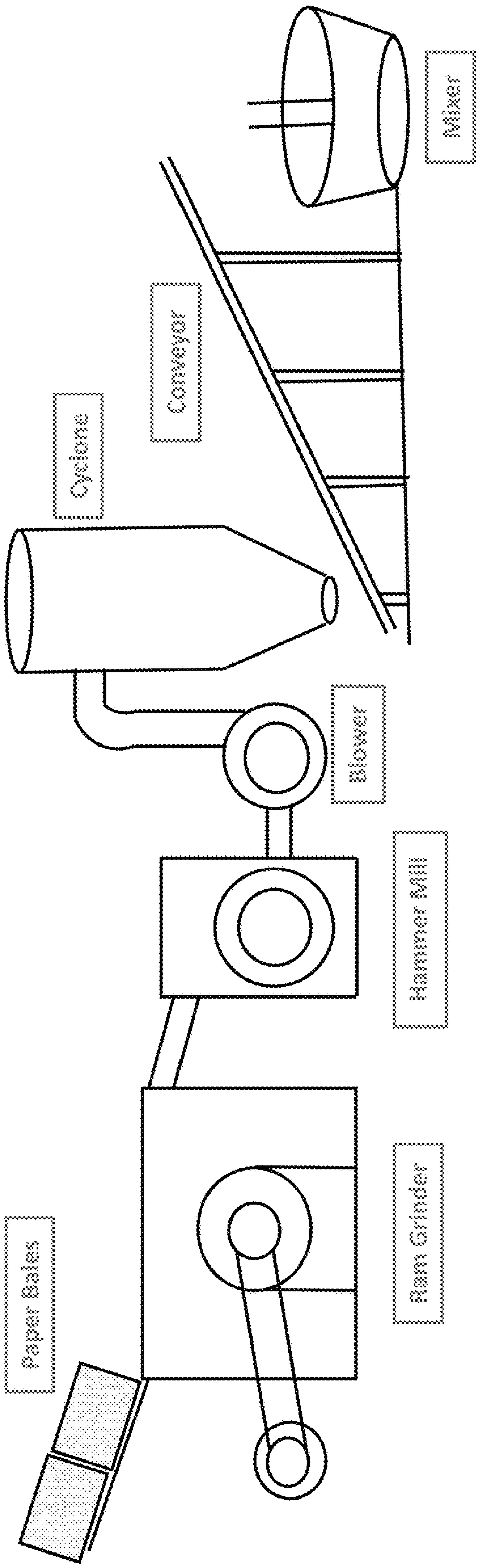
Mixer
Conveyor
Cyclone
Blower
Hammer Mill
Ram Grinder
Paper Bales

FIG. 3

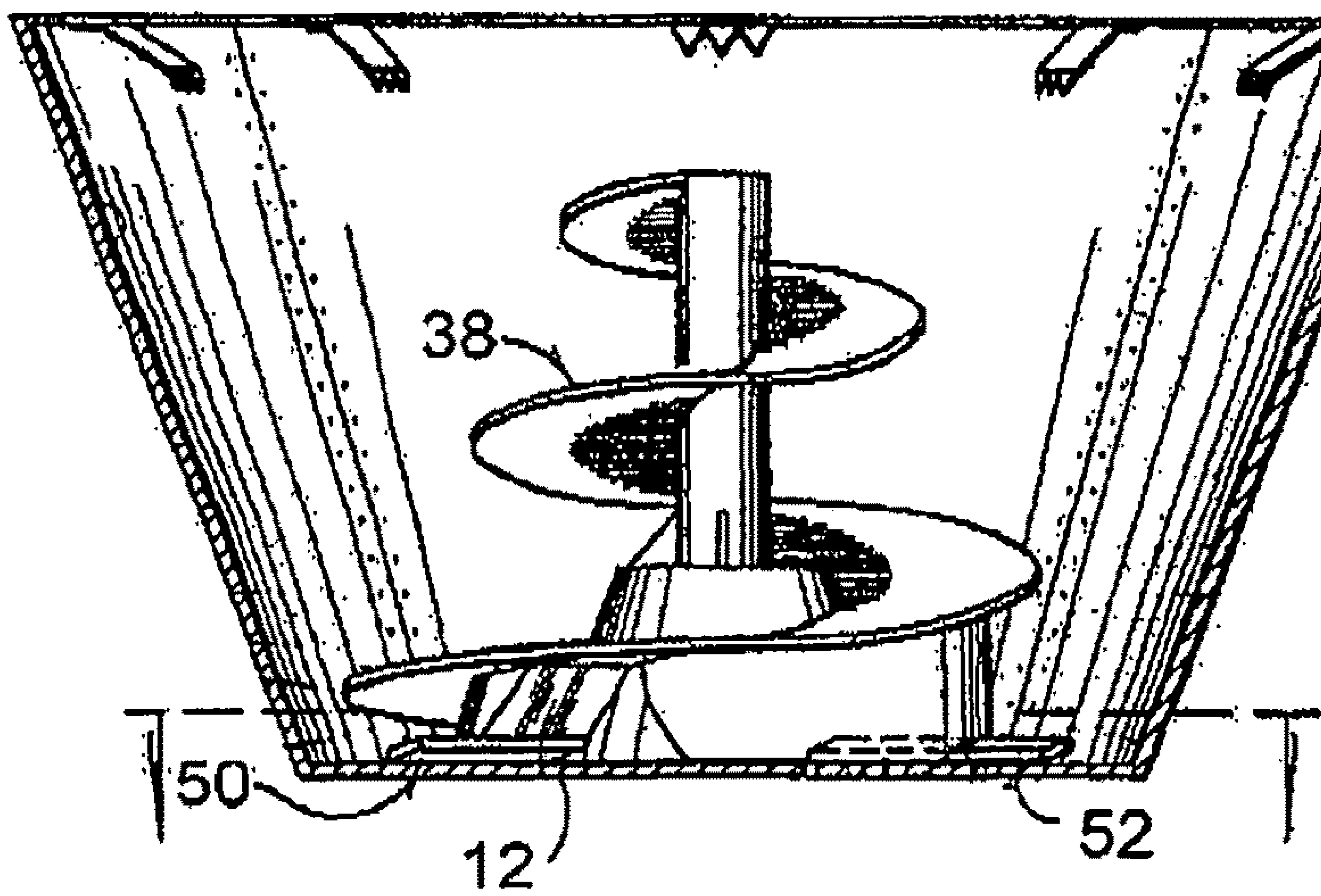

FIG. 4
(Prior Art)

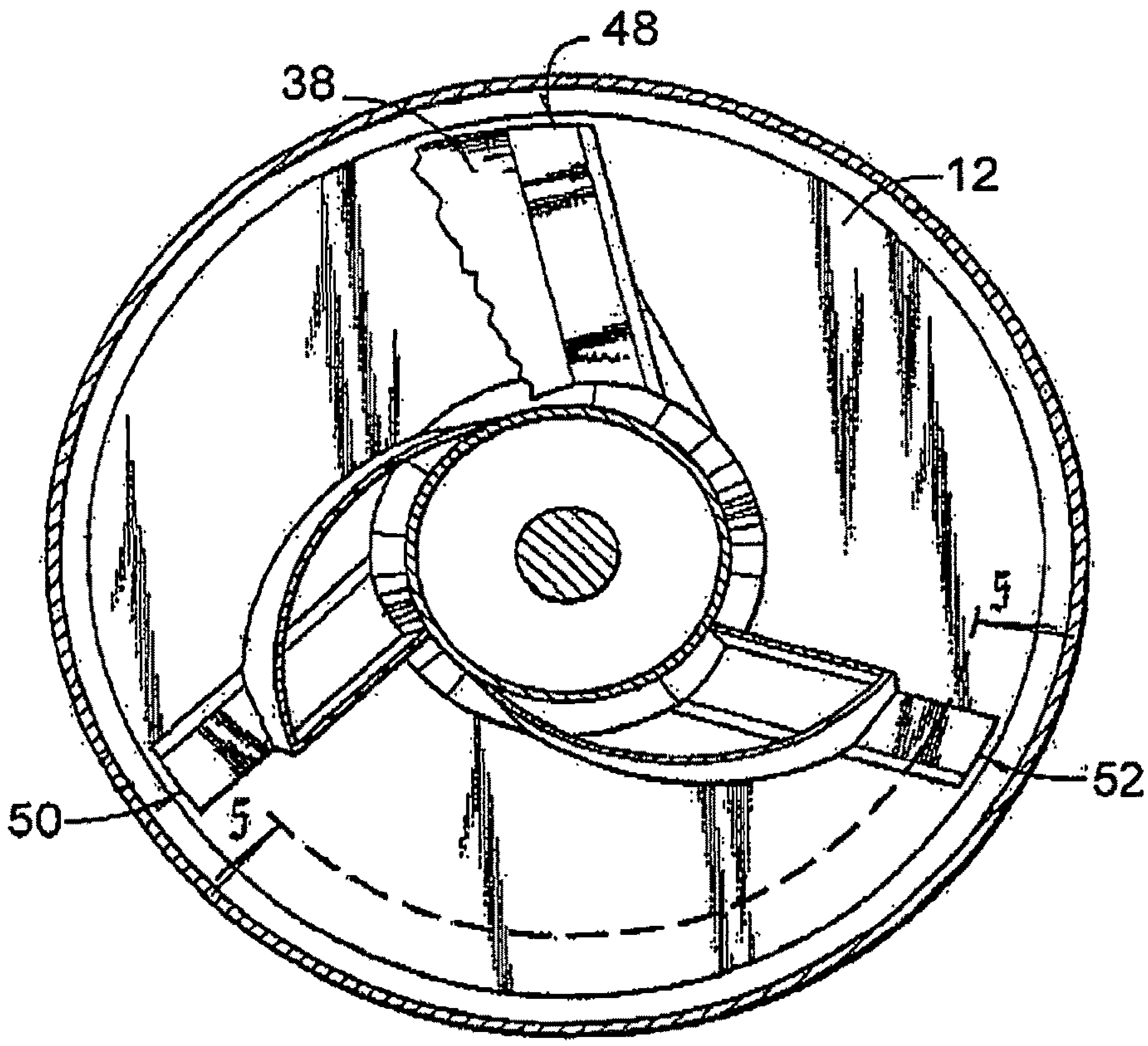

FIG. 5
(Prior Art)

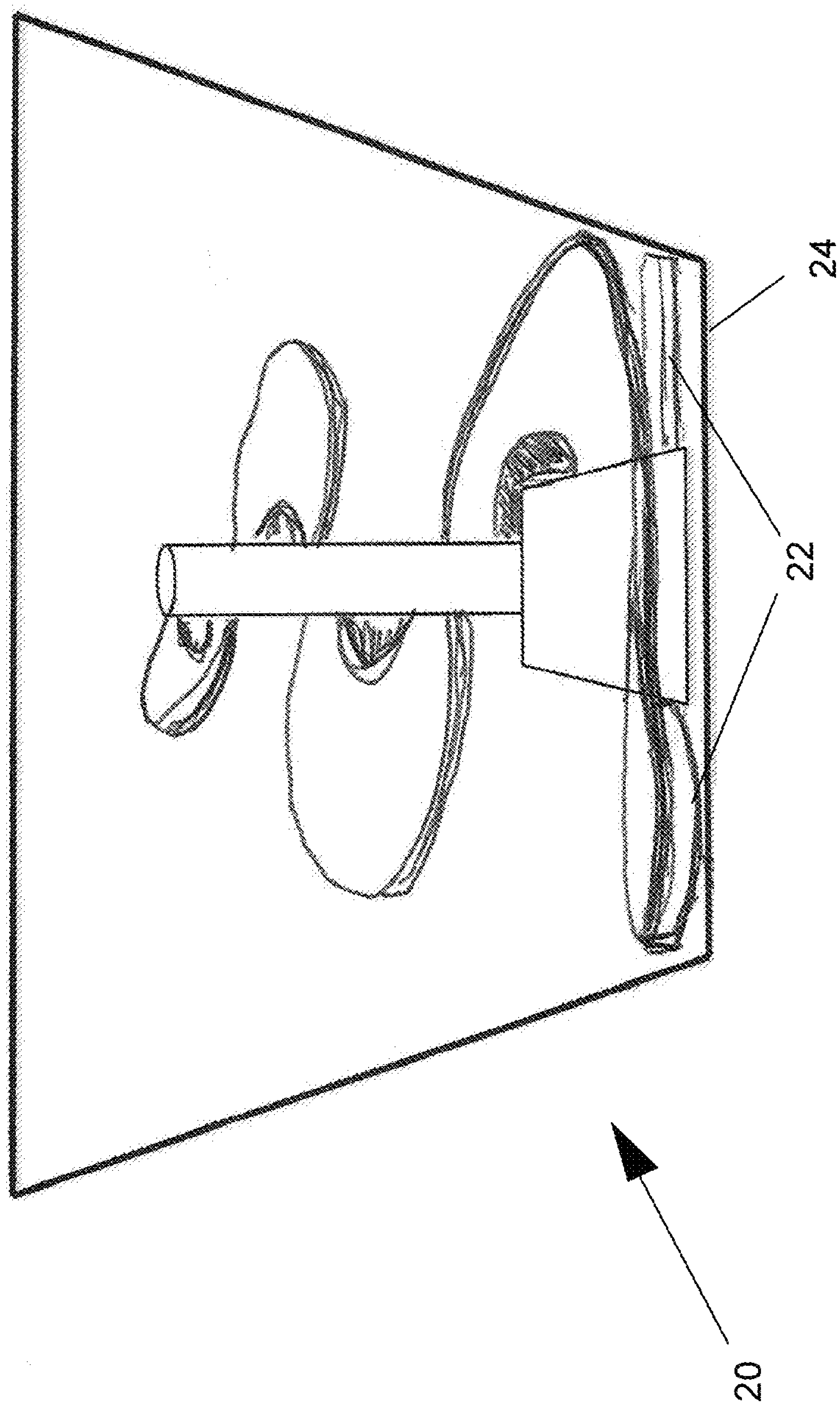

FIG. 6

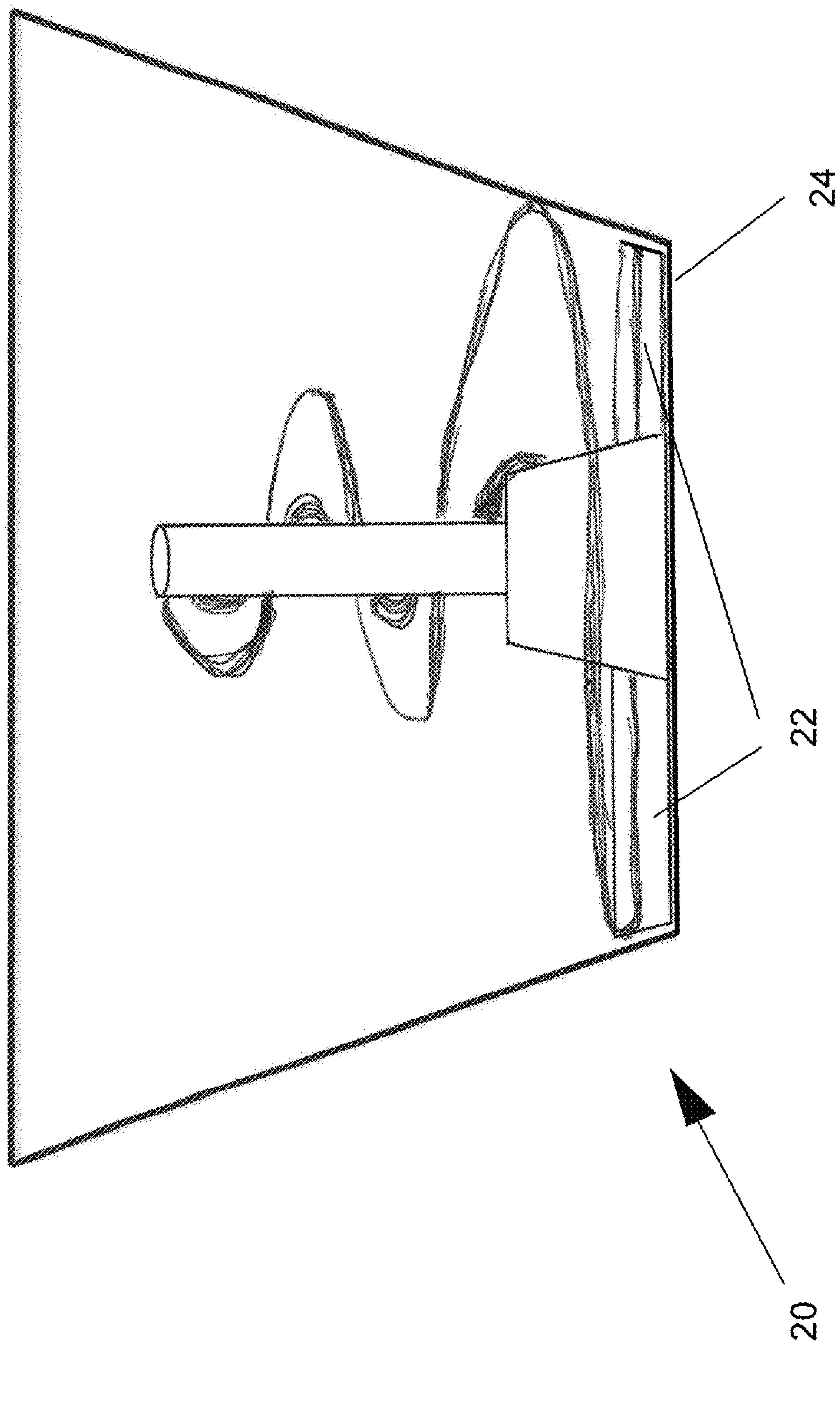

FIG. 7

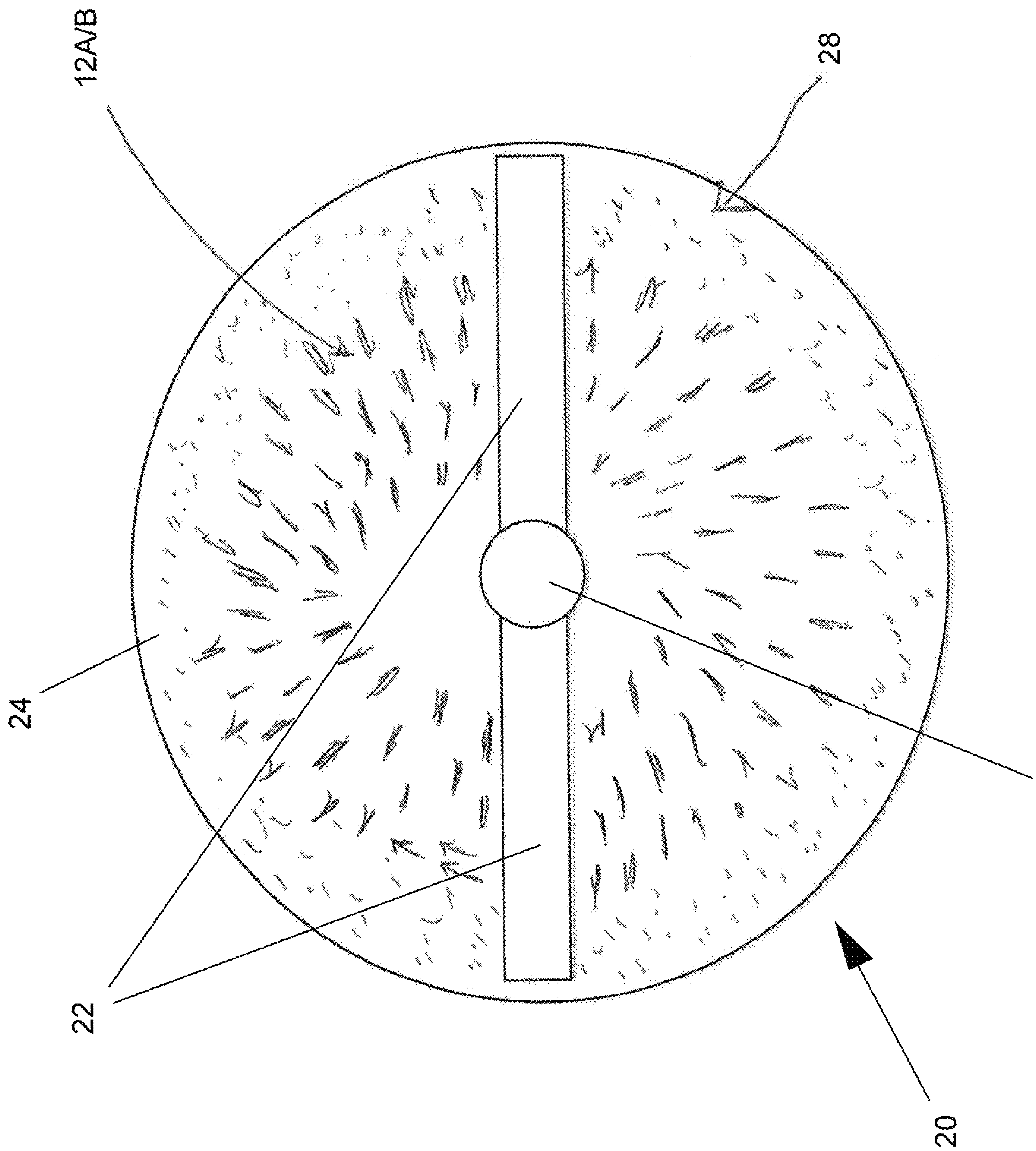

FIG. 8

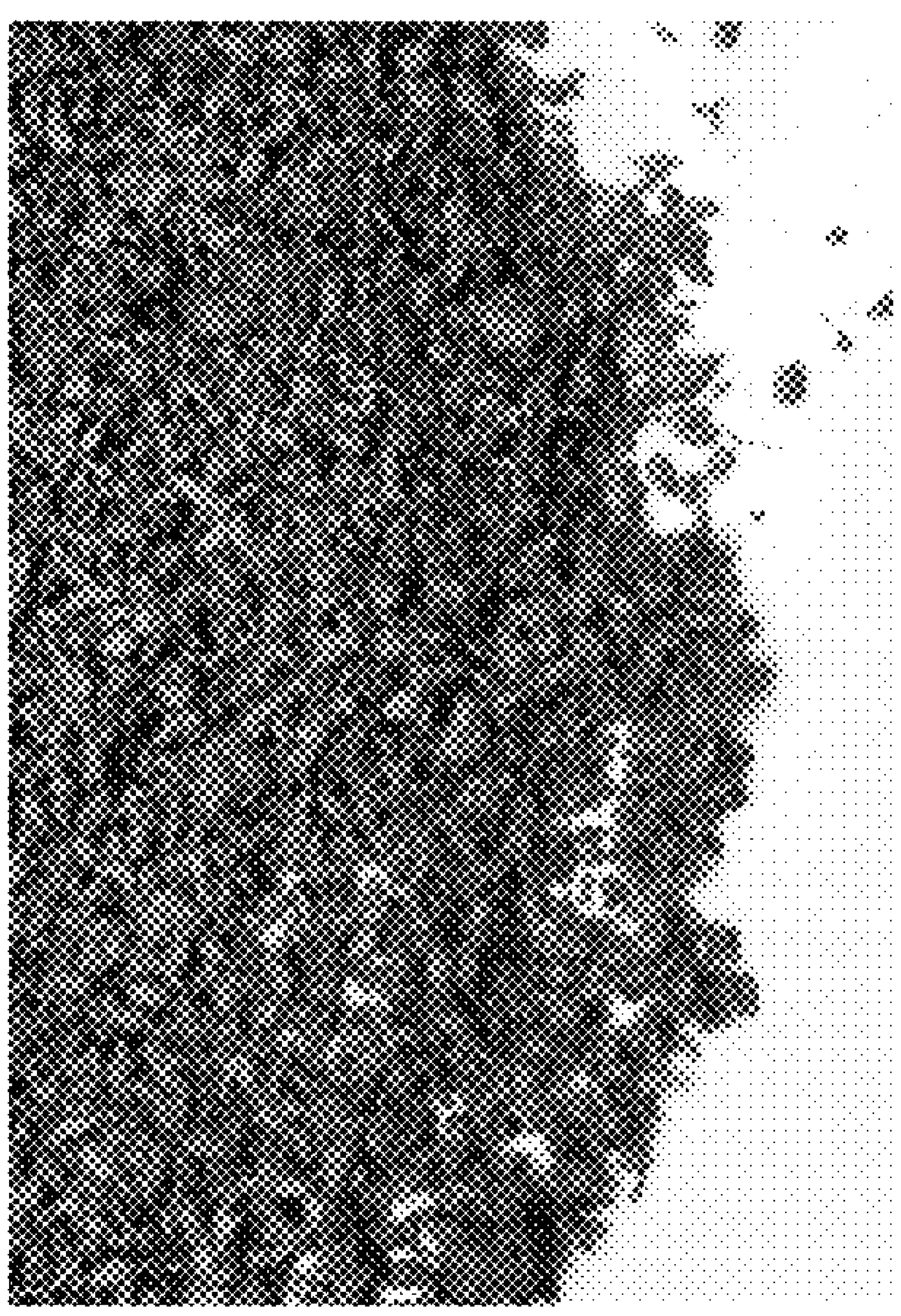
FIG. 9


FIG. 10

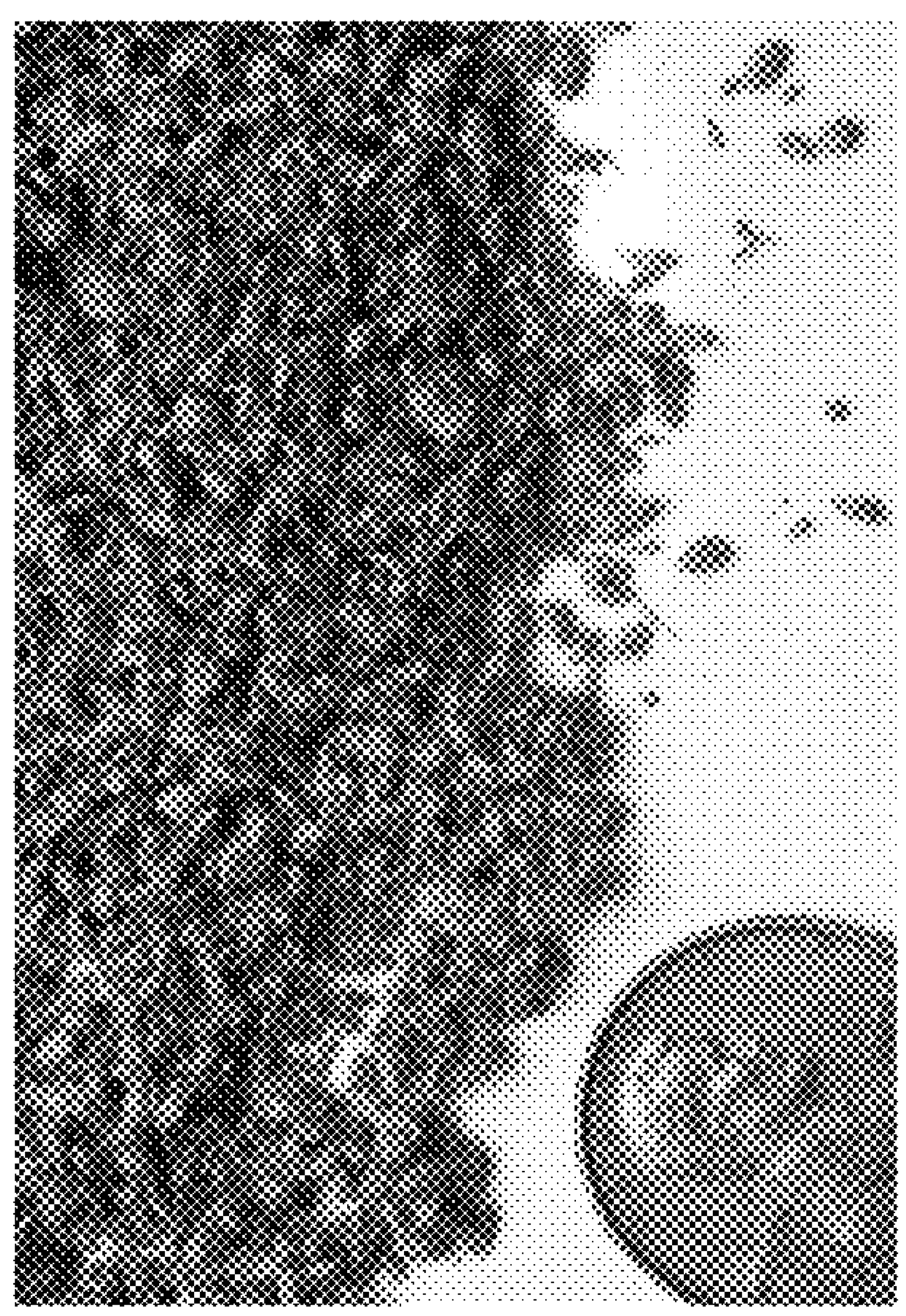
FIG. 11


FIG. 12

FIG. 13

FIG. 14

MATERIALS SUITABLE AS SUBSTITUTES FOR PEAT MOSSES AND PROCESSES AND APPARATUS THEREFOR

This application claims the benefit of U.S. Provisional Application No. 62/060,911, filed Oct. 7, 2014, the contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

The present invention generally relates to materials of types used to improve the aeration and/or moisture retention in soils. More particularly, this invention relates to materials formed from paper-type materials and capable of exhibiting properties that enable their use as substitutes for peat moss.

The use of peat moss, and particularly *Sphagnum* peat moss, for the purpose of conditioning soils is widely practiced by hobbyists and professional gardeners and growers alike. Peat moss is widely used to pack and pot plants, with *Sphagnum* peat moss typically being most preferred by gardeners and growers. When mixed with soil, *Sphagnum* peat moss serves to aerate the soil while simultaneously enhancing moisture retention, both of which are highly desirable soil qualities for starting and growing plants.

Sphagnum peat moss (or simply, *Sphagnum* peat) can be found in bogs predominated by *Sphagnum* moss, a genus of moss. *Sphagnum* peat that is found in the upper layers or more recent growth has not yet had the chance to decay or breakdown, and as a result has desirable characteristics of being long fibered with irregular, clustered branchlets and spherical capsules, which contribute to the ability of *Sphagnum* peat moss to retain moisture when mixed with soil. However, the availability of *Sphagnum* peat moss in the U.S. can be relatively poor as a result of being a limited resource, and *Sphagnum* peat moss accounts for only a fraction of all peat moss produced in the U.S.

In view of increasing environmental concerns, substitutes for various types of natural soil conditioners have been sought by the agricultural industry, with many approaches utilizing recycled materials in order to simultaneously provide a use for solid waste materials. For example, U.S. Pat. No. 3,876,411 to Fowler discloses a mulch which is composed of waste organic materials and latex materials that are byproducts of the manufacturing of polymers. Cellulosic materials such as waste paper have generally been identified as suitable materials for mulches, as recognized by U.S. Pat. No. 4,067,140 to Thomas, U.S. Pat. No. 4,123,489 to Kelley, U.S. Pat. No. 4,297,810 to Hansford, and U.S. Pat. Nos. 4,357,780 and 4,414,776 to Ball. Notably, the above patent documents are generally directed to mulches which, by definition, are intended to be spread on the surface of the soil around plants in order to prevent the evaporation of water from the soil and prevent the plant's roots from freezing. Consequently, these mulches are generally described as having a fibrous character which can be spread or sprayed as an aqueous slurry, or as forming a fibrous web that can be placed in sheet form on the ground. Therefore, these compositions are not directed toward finding a substitute for peat moss, nor are these compositions generally suitable for use as such, primarily due to their large conglomerate nature which inhibits their ability to mix well into the soil.

The horticulture industry has utilized grades in describing peat moss used for various applications. Long-fiber peat moss such as *Sphagnum* is considered to be a premium variety for soil conditioning. It generally is not used for other applications, for example, propagation, seed starting and/or rooting applications, which have specific requirements for moisture retention. Instead, manufacturers of propagation media, including propagation plugs, utilize short fibered peat that will more easily flow through various mechanical apparatus in the production process. Larger fiber materials, including peat mosses, can result in difficult handling and inadequate filling of containers. For commercial and private growers who grow seedlings, a small fiber material more easily fits into small seed or plug trays, whereas larger fiber material, such as *Sphagnum* peat mosses, can cause bridging of the material above seedling tray cavities. With these considerations, the current industry standards for seed starting applications include vermiculite, milled peat moss, and *Sphagnum* peat moss found in lower, more decomposed strata of bogs that contain *Sphagnum* peat moss.

In view of the above, it would be advantageous to provide soil conditioning substitutes for *Sphagnum* peat moss that would exhibit the desired characteristics of this type of moss, such as moisture retention and the ability to readily blend into the soil to provide aeration. It would also be advantageous to provide propagation media substitutes for milled peat moss that would exhibit desirable characteristics, such as moisture retention and the ability to be readily manufactured and used.

BRIEF DESCRIPTION OF THE INVENTION

The present invention provides processes capable of producing materials suitable for use by the horticulture industry, materials produced thereby, and applications for these processes and materials.

According to one aspect of the invention, a bulk material is provided having physical properties similar to peat moss, and the bulk material comprises individual materials, each at least partially having a twisted, curled, clumped and rolled structure. The individual materials may further comprise small granular particles (hereafter referred to as SGPs) dispersed throughout the twisted, curled, clumped and rolled structure. The individual materials may be rolled fibers such that the bulk material has physical properties similar to *Sphagnum* peat moss so as to be particularly suitable as a replacement for *Sphagnum* products when used as, for example, soil conditioners, absorbent materials, chemical carriers, and/or filtering materials (media). Alternatively, the individual materials may be rolled particles such that the bulk material has physical properties similar to milled peat moss so as to be particularly suitable as propagation media.

According to another aspect of the invention, a process and an apparatus are provided for forming the bulk material. The process includes producing a fibrous fluff material, moistening the fluff material and adding small grained particles (SGPs) to the fluff material, and mixing the fluff material and the SGPs so that the SGPs aid in grinding the fluff material and thereby produces individual materials in the form of twisted, curled, clumped and rolled fibers or twisted, curled, clumped and rolled particles that are sufficiently dry to permit separation of the fibers/particles. A sufficient amount of liquid can be added to moisten the fluff material to preferentially produce the rolled fibers but not enough to produce the rolled particles. Alternatively, a relatively greater amount of liquid can be added to the fluff material to preferentially produce the rolled particles instead of rolled fibers.

Significant advantages of certain embodiments of the invention include the ability to provide substitutes for *Sphagnum* peat moss that exhibit certain desirable characteristics of this type of moss, such as moisture retention when used as a soil conditioner. Significant advantages of certain other embodiments of the invention include the ability to provide propagation media substitutes that would exhibit desirable characteristics, such as moisture retention, air exchange and nutrient-holding ability, and the ability to be readily manufactured and used.

Other aspects and advantages of this invention will be further appreciated from the following detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** represents the general appearance of individual fibers and particles of a bulk material in accordance with certain embodiments of this invention.

FIG. **2** is a cross-sectional view of an individual fiber or particle represented in FIG. **1**.

FIG. **3** represents a processing system of a type suitable for producing the fibers and particles of FIGS. **1** and **2**.

FIGS. **4** and **5** are side and top views of a prior art mixer disclosed in U.S. Pat. No. 5,647,665.

FIG. **6** shows a mixer similar to that of FIGS. **4** and **5**, but with a modified blade at its lowermost extent.

FIG. **7** shows a mixer similar to that of FIG. **6**, but with further modified blades at its lowermost extent.

FIG. **8** represents a top view of the mixer of FIG. **6** and showing materials produced by the mixer.

FIGS. **9** and **11** are photographs showing twisted, curled, clumped and rolled particles of a type represented in FIG. **1**,

FIGS. **10** and **12** are photographs showing twisted, curled, clumped and rolled fibers of a type represented in FIG. **1**,

FIG. **13** is a photograph comparing individual fibers and particles of the types represented in FIG. **1** and shown in FIGS. **9** through **12**, and

FIG. **14** is a comparative photograph of *Sphagnum* peat moss.

DETAILED DESCRIPTION OF THE INVENTION

According to the present invention, bulk materials are provided that are suitable for use in the horticulture industry. The bulk materials include soil conditioning media, absorbent materials, chemical carriers, and filtering materials that are suitable as direct substitutes for peat moss and, in preferred embodiments, *Sphagnum* peat moss, and media that are suitable for propagation, seed starting, and/or rooting applications. The bulk materials can be primarily produced from paper products, nonlimiting examples of which are waste paper products including newspapers, which are processed to form small twisted, curled, clumped and rolled fibers or particles, as defined below. The bulk materials can be produced to sufficiently exhibit the textural and physical properties of peat moss, in some cases *Sphagnum* peat moss, such that they can be readily mixed into soil in order to promote moisture retention and enhance aeration in the soil, or used as media for propagation, seed starting and/or rooting applications. Furthermore, the bulk materials preferably contain SGPs of one or more granular materials as a constituent, for example, bone meal alone or in combination with one or more other granular materials. As used herein, an SGP is a small grained particle that is smaller than the paper products used to produce the bulk materials and is abrasive to the paper products. The paper products and SGPs can be processed such that the SGPs aid in the formation of the twisted, curled, clumped and rolled fibers or particles (for convenience, hereinafter referred to simply as rolled fibers and rolled particles, respectively).

For purposes of this invention, SGPs can be composed of any solid material that remains solid or will fragment or dissolve during processing or over time in the use of the bulk materials. The solid material and SGPs formed thereof can be ground, sized, formulated, and/or synthesized naturals or manufactured materials. As an example, SGPs may be solid materials derived from processed agricultural products, by-products, or waste from processing such as (but not limited to) those of the type derived from food, fiber, fuel, fisheries, forestry and other production and processing systems. These solid materials include but are not limited to many agricultural products and by-products; as nonlimiting examples, bone meal, hoof and horn materials, ground shells, ground pits or seeds, coffee grounds, chaff, hulls, brewery waste and granulated products of fermenting and fuel production, ground shells, ground or processed forestry products, and combinations thereof. SGPs may also be solid materials derived from mining and earthen particles that have been processed to formulate granules. Minerals and ores of all types can range in size from sand to silt and clay, and may be reconstituted to granules that have a desired particle size as discussed below. These solid materials include but are not limited to calcined clay, fused earth products, pumice, volcanic ash, perlite, vermiculite, gypsum, lime, fertilizers, coal fines, rock dust, and any combinations thereof. SGPs may also be solid materials derived from recycled products that have been processed to formulate granules of the desired particle size. Nonlimiting examples of waste materials that can be used include materials from manufacturing and processing, construction, excavation, food preparation and food delivery services, and any other waste materials that can be milled processed or granulated to the desired particle sizes. These solid materials include but are not limited to ground glass, concrete, asphalt, and metal, food service containers, solidified fibers, plastics, and processed plastics, and various other waste and recycled products. SGPs may also be any solid material that will remain solid for a part of the processing and/or into the application of the finished material. In view of the foregoing, the source and formulation of the SGP can vary depending on the properties and desired application of the bulk material. In some instances, the SGP can be selected to alter the nutrient properties of the bulk material and therefore the ability of the material to promote plant growth. As a nonlimiting but in some instances preferred SGP, bone meal (calcium phosphate) advantageously contributes fertilizer-grade phosphorus and nutrient-grade calcium to the bulk material.

The bulk materials of this invention are able to utilize waste paper that typically comprises lignin and cellulose, such as newsprint, which has been shredded to form small shredded fragments, more preferably a fluff material referred to herein as a cellulose fluff material. Vigorous blending with the SGPs and a controlled amount of liquid transforms the fluff material into the above-noted rolled fibers or rolled particles. The rolled fibers or rolled particles have a sufficiently small size in order to exhibit desired physical characteristics, preferably simulating either *Sphagnum* peat moss or milled peat moss, depending on the intended application, for example, as a soil conditioner, absorbent material, chemical carrier, filtering material, or propagation media. The SGPs can become distributed within the rolled fibers or rolled particles and may optionally form a layer that individually and substantially encases each of the rolled fibers or rolled particles. For example, if present as a cohesive layer, agricultural grade bone meal can assist in the retention of moisture in each of the rolled fibers or rolled particles, and may also contribute fertilizer, for example, fertilizer grade phosphorus. The bulk materials (for example, soil conditioner, absorbent material, chemical carrier, filtering material or propagation media are thereby composed of a mass of individual rolled fibers or rolled particles, and are preferably characterized by a texture and a moisture-retention capability which is comparable to that of either *Sphagnum* peat moss or peat moss, including milled peat moss.

The physical characteristics of the materials which enable the above are generally represented in FIGS. **1** and **2**, which illustrate a bulk material **10** as individual materials (pieces or bodies) **12** having the aforementioned "rolled" form, more particularly, a twisted, curled, and/or-clumped shape and a rolled structure. Some of the materials **12** have a more elongate shape, referred to herein as the rolled fibers **12**A, whereas the remainder are smaller and referred to herein as the rolled particles **12**B, in some instances having a more spherical shape than the rolled fibers **12**A. The rolled fibers **12**A and rolled particles **12**B can be selectively produced by adjusting the processing method by which they are created, as will be described below. The rolled particles **12**B have a smaller, tighter, denser fibrous structure that is particularly desirable for use in propagation, seed starting and/or rooting applications in small seed starting cells or any other application as a substitute for milled peat moss or similar material. In contrast, the rolled fibers **12**A have a looser, loftier fibrous structure that is particularly desirable for use as a soil conditioner, absorbent material, chemical carrier, or filtering material, filling large containers for bedding plants and hanging baskets, or any other application as a substitute for *Sphagnum* peat moss or similar material. Notably, the smaller size of the rolled particles **12**B enables a bulk material **10** of the rolled particles **12**B to more easily flow through various mechanical equipment that might be used in a production process to produce propagation plugs, or if used to fill small seedling tray cavities.

Generally, it is preferable that the largest dimensions (lengths) of the rolled fibers **12**A and rolled particles **12**B do not exceed about eight millimeters, for example, about one millimeter up to a maximum dimension of about six to eight millimeters, in order to ensure that they can be readily mixed with soil. In practice, for example, at least some and preferably most of the rolled fibers **12**A are greater than two millimeters and up to about five millimeters in length and, as evident from FIG. **1**, the rolled particles **12**B tend to be smaller than the rolled fibers **12**A, for example, at least some if not most are less than 2.5 millimeters in length. As such, the maximum dimensions for the rolled fibers **12**A and rolled particles **12**B are believed to result in both forms of the material **10** being physically distinguishable from traditional mulch materials. The rolled fibers **12**A and rolled particles **12**B can preferably be readily mixed with shovels or trowels typically used by both commercial growers and home gardeners. However, it is foreseeable that larger sized rolled fibers **12**A and rolled particles **12**B may be suitable under some circumstances.

As shown in FIG. **2**, each individual rolled fiber **12**A and particle **12**B is generally composed of a core **14** formed almost entirely of cellulose fiber. SGPs **16** of a granular material, for example, bone meal, are represented as being dispersed throughout the fiber/particle material **12**. The SGPs **16** may optionally form a cohesive layer that substantially encases the rolled fiber **12**A or rolled particle **12**B. The manner in which the rolled fibers **12**A and rolled particles **12**B are produced preferably yields the generally rolled or coiled structure shown for the core **14**, while the SGPs **16** may be absorbed somewhat into the core **14**, particularly between overlapping portions of the core **14**. The source of the cellulose fiber can vary considerably. Cellulose insulation has been used, though waste paper, particularly newsprint, is preferred due to availability, relatively low cost, and ability to be readily processed to form the desired rolled fibers **12**A and rolled particles **12**B shown in FIG. **1**. For example, the processing of newsprint can be controlled to readily produce the relatively loose rolled fibers **12**A or the more tightly wound rolled particles **12**B represented in FIG. **1**. The rolled structure of the core **14** enhances the ability of the rolled fibers **12**A and rolled particles **12**B to retain moisture, which is a desirable characteristic of peat moss and any composition intended as a replacement for peat moss.

Processes that are believed to be preferred for the production of the materials **10** are highly advantageous from the standpoint of material and processing costs. As represented in FIG. **3**, the processes primarily include a shredding operation in which paper such as newsprint is reduced to cellulose particles or fluff material. In FIG. **3**, such a shredding operation may start with bales of paper that are processed by a ram grinder and then a hammer mill, resulting in the cellulose fluff material that is blown into a cyclone/dust collector to remove excessively fine particles. The fluff material is then gently deposited onto a conveyor and fed into a finish mixer. Suitable ram grinders, hammer mills, cyclone/dust collectors, and conveyors are well known and will not be discussed in any further details.

Within the mixer, the cellulose fluff material is combined with water, the SGPs (for example, bone meal), and optionally any desired colorant(s) and/or additional additives. Within the mixer, the fluff material is moistened and, in a process that is believed to involve the action of the SGPs, substantially transformed into the rolled fibers **12**A or rolled particles **12**B. Sufficient moisture is present in the mixer such that the SGPs **16** form a slurry that promotes grinding of the fluff material, and may optionally form the aforementioned cohesive layer that substantially covers the individual rolled fibers **12**A or rolled particles **12**B. In particular, the SGPs **16** are believed to have a significant role as an abrasive agent in the mixing process. The SGPs **16** appear to play a significant role in breaking down the cellulose fluff material as the mixture of fluff material and SGPs **16** is ground/milled beneath a lowermost blade of the mixer. Mixing preferably continues for a duration sufficient to permit separation of the rolled fibers **12**A or rolled particles **12**B, such that a mass of the rolled fibers **12**A or rolled particles **12**B is characterized by a desirable texture and moisture-retention capability. If present, the cohesive layer of bone meal on each rolled fiber **12**A or rolled particle **12**B assists in the retention of moisture within each rolled fiber **12**A or rolled particle **12**B.

An example of a known type of mixer is represented in FIGS. **4** and **5**. The mixer, which is disclosed in U.S. Pat. No. 5,647,665, is intended as a feed mixer, for example, to produce silage for cattle. FIGS. **4** and **5** show the mixer as having a corkscrew-like auger **38** and lowermost grader blades **48**, **50** and **52**, the latter of which are spaced apart from the floor **12** of the mixer. FIGS. **6** and **7** represent mixers **20** that are similar to that of FIGS. **4** and **5**, but modified such that at least a portion of at least one of their lowermost blades (sweep bars or swing arms) **22** is in closer proximity to the floor **24** of the mixer **20** than that represented in FIGS. **4** and **5**. The mixer **20** in FIG. **6** has at least one bent lowermost blade **22** having a portion in closer proximity to the floor **24** than the remainder of the blade **22**, whereas the entirety of each blade **22** of the mixer **20** in FIG. **7** has roughly the same tight clearance with the floor **24** as the bent portion of the blade **22** of FIG. **6**. The tight clearance is believed to be a key factor in the manipulation of the cellulose fluff material into the desired rolled fibers **12**A or rolled particles **12**B, as longer chains of fibers/particles appeared beneath the bend with each rotation of a mixer configured similar to the mixer **20** of FIG. **6**. In that particular embodiment of the mixer **20**, at least one of its lowermost blades **22** had a downward bend spaced apart from the radial outermost end of the blade **22**, roughly starting about 5 to 6 inches (about 7.5 to 15 cm) from the radial outermost end of the blade **22** and continuing about 12 to 14 inches (about 30 to 35 cm) toward the center of the shaft **26** on which the auger and blades **22** were mounted. In investigations leading to the present invention, the mixer configured as shown in FIG. **6** appeared to exclusively produce rolled fibers **12**A or rolled particles **12**B beneath the bend in its lowermost blade **22**, as represented in FIG. **8**. In contrast, beneath portions of the blades **22** spaced farther from the floor **24** of the mixer **20**, only small cellulose particles **28** were observed but no formation of rolled fibers **12**A or rolled particles **12**B. The cellulose particles **28** visually appeared as if they have not yet been affected or manipulated by the blades **22**. Tighter clearances as described above were also tested in a closed batch ribbon mixer and appeared to duplicate the desired characteristics of rolled fibers **12**A or rolled particles **12**B that were produced with the mixer **20** of FIG. **6**.

The twisted, clumped and rolled structures of the rolled fibers **12**A and rolled particles **12**B are advantageous when mixing the material **10** into soil, in that the rolled fibers **12**A or rolled particles **12**B will more readily mix into the soil than would shredded or fibrous particles, yet the rolled fibers **12**A and rolled particles **12**B also retain some of the advantages of a fibrous structure as a result of being formed from fibrous fluff material. In particular, it is believed that the internal fibrous nature of the rolled fibers **12**A and rolled particles **12**B, as opposed to their external clumped structure, serves to extend the longevity of the cellulosic food for microbes within the soil.

As is known in the art, bone meal is a product made by grinding animal bones, with commercially available bone meal generally containing tricalcium phosphate and phosphoric acid, with smaller amounts of ammonia also being present. Bone meal is believed to be preferred as the SGPs **16** for this invention and is preferably of the type designated as fertilizer grade, which is raw bone meal that has not been previously steamed, though steamed bone meal, generally designated as feed grade bone meal, could also be used. In some embodiments, the SGPs **16** of bone meal may constitute a weight percent of as low as about 0.2% to as high as about 35% of each of the rolled fibers **12**A or rolled particles **12**B, based on the mixing rate of bone meal with the fluff material, though it is entirely foreseeable that greater or lesser amounts of bone meal could be utilized and yet obtain rolled fibers **12**A and rolled particles **12**B suitable for use under some conditions. Furthermore, part or all of the bone meal could be replaced with another granular material that meets the definition herein of an SGP, a notable but non-limiting example of which is sand. The SGP type and the final moisture content of the bulk material may vary considerably to meet specific applications. The resulting bulk material **10** may have a density as low as about 50 grams per liter to as high as about 1500 grams per liter. A preferred range for use as a substitute for common peat moss or milled peat applications is believed to be from about 70 to about 400 grams per liter, which advantageously is comparable to that of peat moss as used for agricultural purposes.

As a result of the above structure, the bulk materials **10** of this invention are capable of exhibiting textural and moisture-retention characteristics very similar to that of *Sphagnum* peat moss or milled peat moss, in that the rolled fibers **12**A and rolled particles **12**B are suitable substitutes for, respectively, *Sphagnum* peat moss as a soil conditioning agent or milled peat moss as a propagation media. The materials **10** may also provide benefits beyond those of *Sphagnum* and milled peat moss, for example, as a result of containing bone meal as the SGP, which contributes phosphorus to the soil for stimulating plant growth. Furthermore, if part or all of the bone meal is replaced with another SGP and/or an additional additive is combined with the cellulose fluff material and SGP, the SGP and/or additive can be selected to alter the nutrient properties and/or non-nutrient properties (physical, chemical, and biological) of the materials **10** (as examples, plant protecting materials such as bio-stimulants, growth regulators, natural and chemical pesticides, fungal and bacterial inoculants, etc.), and thereby enhance the ability of the material **10** to promote plant growth.

Processes by which either the rolled fibers **12**A or rolled particles **12**B can be selectively produced generally relate to the amount of liquid used in the process. Typically the liquid will be water that is added to the mixer **20** in an amount sufficient to moisten the cellulose fluff material and SGPs **16**, though it is foreseeable that other liquids could be used as long as the liquid is biologically compatible with the intended purpose of the bulk material **10**. As previously noted, the SGPs **16** preferably have an abrasive effect to promote the breaking down of the cellulose fluff material as the mix of cellulose fluff material and SGPs **16** is ground and/or milled beneath the lowermost blade(s) **22** of the mixer **20**. Before, during or after the addition of SGPs **16**, additional liquid can be introduced into the mixer **20**, as well as any coloring agent or other desired liquid or solid additive. However, a relatively greater amount of moisture is required to produce the rolled particles **12**B, which results in the creation of a slurry with the cellulose fluff material that promotes the formation of the desired rolled particles **12**B. After a period of continuous mixing, the cellulose fluff material is transformed into a substantially homogenous mass of rolled fibers **12**A or rolled particles **12**B.

Once the physical shape of the rolled fibers **12**A or rolled particles **12**B is acquired, mixing may continue for a duration sufficient to dry the rolled fibers **12**A or rolled particles **12**B, for example, sufficient to permit the rolled fibers **12**A or rolled particles **12**B to be freely separated and subsequently handled for packaging. Bulk materials **10** formed of either the rolled fibers **12**A or rolled particles **12**B as described above have been evaluated for water absorption, water retention and aeration capacity, with excellent results. Commercial trials have also shown that these bulk materials **10** are able to achieve better propagation success rates than vermiculite and milled peat moss.

Grinding/milling processes applied as described above to the manufacturing the bulk material **10** appears to alter the fiber structure of the feed material (e.g., recycled newspaper) to create materials **12** having a desirable combination of properties, including high porosity and low bulk density. Increased porosity promotes oxygen exchange to the roots of plants and enhances availability of water. Low bulk density provides ease of handling and reduces shipping costs. FIGS. **9** and **11** are photographs of rolled particles **12**B produced in accordance with the above description, FIGS. **10** and **12** are photographs of rolled fibers **12**A produced in accordance with the above description, and FIG. **13** is a photograph showing a side by side comparison of the two. Significant features of the rolled fibers **12**A and rolled particles **12**B that can be seen in these images include a clumped, curled, twisted, and rolled, rearranged cellulose material having a consistent, milled fiber size or particle size that is favorable to achieving a uniform moisture-holding, oxygen-holding and fertilizer-holding capacity, promoting the use of rolled particles **12**B and particularly the rolled fibers **12**A as an absorbent material or chemical carrier. The clumped, curled, and twisted shape of the cellulose material can also promote the use of a mass of the rolled fibers **12**A and/or rolled particles **12**B as a filtering material. Unseen in FIGS. **9** through **13**, but determined by other methods, was high porosity characterized by a consistent pore space that is critical to a more uniform moisture-holding, oxygen-holding, fertilizer-holding, or filtering capacity, and a moisture-holding capacity that exceeds by up to about 170% by weight that of long fiber *Sphagnum* peat moss without a surfactant or wetting agent. Significantly, the increased moisture retention and oxygen exchange likely increase the reliability of seed germination, for example, up to about 97% in experimental trials.

In contrast, significant features of peat moss that can be seen in FIG. **14** include a lack of consistent particle size, and a flat fiber structure that has been expanded as the result of the application of a surfactant. As known in the art, peat moss must have a surfactant or wetting agent to promote moisture retention. In contrast, the rolled fibers **12**A and rolled particles **12**B have been shown to have an affinity for water, and readily absorb water when very dry.

From the above, it can be seen that a significant advantage of this invention is that the bulk materials **10** can be selectively produced from similar materials, yet have different characteristics that render them particularly suitable as substitutes for either *Sphagnum* peat moss or milled peat moss.

While the invention has been described in terms of specific embodiments, it is apparent that other forms could be adopted by one skilled in the art, such as by modifying the shape of the rolled fibers **12**A or rolled particles **12**B, utilizing different sources of cellulose fluff material, adding adjuncts during blending which do not materially alter the desired physical and/or textural properties of the materials **10** and their rolled fibers **12**A and rolled particles **12**B, altering or modifying the processing steps described above yet achieving the desired rolled fibers **12**A or rolled particles **12**B described, or employing the material **10** for purposes other than a substitute for peat moss. Accordingly, it should be understood that the invention is not limited to the specific embodiments illustrated in the Figures. It should also be understood that the phraseology and terminology employed above are for the purpose of disclosing the illustrated embodiments, and do not necessarily serve as limitations to the scope of the invention. Therefore, the scope of the invention is to be limited only by the following claims.

The invention claimed is:

1. A bulk material for use in the horticulture industry as a substitute for *Sphagnum* peat moss and having a bulk density of 70 to 150 grams per liter and physical properties that enable the bulk material to be mixed into soil in order to promote moisture retention and enhance aeration in the soil and/or used as media for propagation, seed starting and/or rooting applications, the bulk material comprising porous individual materials having a rolled form, each porous individual material comprising abrasive small granular particles (SGPs) dispersed in a core comprising rearranged shredded fragments of a cellulose material and having an internal fibrous structure, porosity characterized by internal pores for moisture-holding, and an external structure comprising the following shapes: twisted, curled, and clumped;

wherein:

the core has a coiled structure with overlapping portions;

all of the SGPs are individually distributed and dispersed throughout the internal fibrous structures and the external structures of the cores and between the overlapping portions of the cores;

at least some of the SGPs are confined within the cores;

the bulk material has a texture of *Sphagnum* peat moss; and

the SGPs are a size of about 1/16 to about 1 mm.

2. The bulk material as recited in claim **1**, wherein the SGPs comprise gypsum.

3. The bulk material as recited in claim **1**, wherein the largest dimensions of the porous individual materials do not exceed eight millimeters.

4. The bulk material as recited in claim **1**, wherein the bulk material is a soil conditioner.

5. The bulk material as recited in claim **1**, wherein the bulk material is a propagation media.

6. The bulk material as recited in claim **1**, wherein the bulk material is an absorbent material.

7. The bulk material as recited in claim **1**, wherein the bulk material is a chemical carrier.

8. The bulk material as recited in claim **1**, wherein the bulk material is a filtering material.

9. The bulk material as recited in claim **1**, wherein the bulk material consists of the porous individual materials.

10. The bulk material as recited in claim **1**, wherein the bulk material has a moisture-holding capacity that by weight exceeds *Sphagnum* peat moss.

11. The bulk material as recited in claim **1**, wherein the SGPs comprise a solid material that remains solid or fragments or dissolves during use of the bulk material.

12. The bulk material as recited in claim **1**, wherein the SGPs comprise one or more of hoof and horn materials, ground shells, ground pits, ground seeds, coffee grounds, chaff, hulls, brewery waste, granulated products of fermenting and fuel production, ground shells, ground or processed forestry products, calcined clay, sand, fused earth products, pumice, volcanic ash, perlite, vermiculite, gypsum, lime, fertilizer, coal fines, rock dust, ground glass, concrete, asphalt, metal, food service containers, solidified fibers, plastics, and processed plastics.

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